

INCH-POUND

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DETAIL SPECIFICATION

CHROMEL AND ALUMEL THERMOCOUPLE ELECTRICAL WIRE



Comments, suggestions, or questions concerning this document should be addressed to AMSRD-AMR-SE-TD-ST Redstone Arsenal, AL 35898-5000 or e-mailed to malinda.allcorn1@us.army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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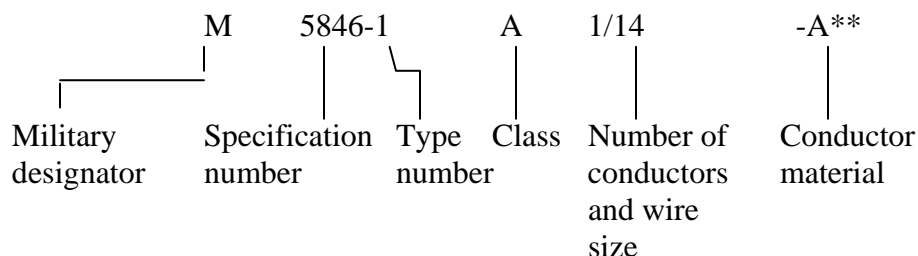
1. SCOPE

1.1 Scope. This specification covers chromel and alumel thermocouple wire (see 6.5).

1.2 Classification. The thermocouple wire shall be of the following types and classes:

- Type 1 Solid and stranded conductor
 Class A – Bare (solid conductor)
 Class B – Insulated (solid conductor)
 Class C – Insulated duplex (solid conductor)
 Class D – Insulated (stranded conductor)
 Class E – Insulated duplex (stranded conductor)
- Type 2 Insulated duplex, stranded conductor (7 ohms per 25 feet)
 Class A – Stranded insulation
- Type 3 Insulated duplex, stranded conductor (7 ohms per 50 feet)
 Class A – Stranded insulation
- Type 4 Insulated duplex, stranded conductor (7 ohms per 100 feet)
 Class A – Stranded insulation

1.2.1 Military part number. The military part number shall consist of the letter “M,” the basic number of the specification, and an assigned dash number as shown below. Information to be inserted shall be derived from 1.2 above and Table I.



** For single conductor wire the wire material shall follow the wire size preceded by a dash. A=Alumel. C=Chromel.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are cited.

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2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

TT-I-735 - Isopropyl Alcohol

COMMERCIAL ITEMS DESCRIPTIONS

A-A-52624 - Multi-engine Type Antifreeze

DEPARTMENT OF DEFENSE

SPECIFICATIONS

MIL-DTL-12000 - Packaging of Electric Cable, Cord, and Wire

STANDARDS

MIL-STD-120 - Marking for Shipment and Storage
 MIL-STD-130 - Identification Marking of US
 Military Property
 MIL-STD-810 - Environmental Test Methods

(Copies of these documents are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094, or online at <http://assist.daps.dla.mil/quicksearch/>.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D471 - Rubber Property – Effects of Liquids

(Copies of this document are available from American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, or online at <http://www.astm.org>).

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SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE J1966 - Aircraft Piston Engine
(Nondispersant Mineral) Lubricating
Oils

(Copies of this document are available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001, or online at <http://www.sae.org>.)

3. REQUIREMENTS

3.1 Preproduction. Unless otherwise specified, preproduction inspection is required and preproduction samples shall meet the requirements specified herein (see 6.2.1).

3.2 Material. Reclaimed materials shall be required to the maximum extent possible without jeopardizing the intended use of the item.

3.3 Construction. The wire shall be constructed as follows:

Type 1	Class A – Bare solid chromel or alumel conductor
Type 1	Classes B and D
	First – Solid or stranded chromel or alumel conductor
	Second – Inner wrap (if required)
	Third – Primary insulation
	Fourth – Layer of braid, fibrous covering or other approved material (if required)
	Fifth – Outer protective coating (if required)
Type 1	Classes C and E
	First – Solid or stranded chromel and alumel conductors
	Second – Inner wrap (if required) (individual conductors)
	Third – Primary insulation (individual conductors)
	Fourth – Layer of braid, fibrous covering or other approved material (if required) (individual conductors)
	Fifth – Chromel and alumel insulated wires laid in parallel and covered with duplexing outer coating
	Sixth – Outer protective coating (if required)
Types 2, 3, and 4	Class A
	First – Stranded chromel and alumel conductors

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- Second – Inner wrap (if required) (individual conductors)
 Third – Primary insulation (individual conductors)
 Fourth – Layer of braid, fibrous covering or other approved material (if required) (individual conductors)
 Fifth – Chromel and alumel insulated wires laid in parallel and covered with duplexing outer covering
 Sixth – Outer protective coating (if required)

3.3.1 Conductors.

3.3.1.1 Metals. The conductors shall consist of chromel or alumel as specified herein and shall be of such quality as to produce the characteristics specified herein. The conductors shall be free from lumps, kinks, splits, abrasions, and scraped or corroded surfaces.

3.3.1.2 Stranding. Stranding may be bunched, concentric or rope lay and as specified in Table I. The wire sizes of all strands shall be the same for any one conductor except for Types 2, 3, and 4, where strand size may vary to facilitate resistance adjustments.

TABLE I. Details of wire construction.

Type	Class	American Wire Gage	Nominal Conductor Diameter (inches)	Nominal Conductor Area (circular mils)	Maximum Diameter of Finished Wire (inches)	Number of Strands (min)	Weight Lb (max)
1	A	14	0.0641	4107			
		16	0.0508	2583			
		18	0.0403	1624			
		20	0.0320	1021			
		26	0.0159	254			
1	B	14	0.0641	4107	0.150		
		16	0.0508	2583	0.130		
		18	0.0403	1624	0.115		
		20	0.0320	1021	0.110		
		26	0.0159	254	0.070		
1	C (See Note 1)	14	0.0641	4107	0.315		
		16	0.0508	2583	0.275		
		18	0.0403	1624	0.245		
		20	0.0320	1021	0.225		
		26	0.0159	254	0.155		
1	D	14	0.080	4107	0.170	9	
		16	0.063	2583	0.150	8	
		18	0.048	1624	0.135	7	
		20	0.039	1021	0.115	4	
		24	0.025	404	0.090	3	
		26	0.020	254	0.075	3	

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TABLE I. Details of wire construction – Continued.

Type	Class	American Wire Gage	Nominal Conductor Diameter (inches)	Nominal Conductor Area (circular mils)	Maximum Diameter of Finished Wire (inches)	Number of Strands (min)	Weight Lb (max)
1	E (See Note 1)	14 16 18 20 24 26	0.080 0.063 0.048 0.039 0.025 0.020	4107 2583 1624 1021 404 254	0.355 0.305 0.275 0.245 0.195 0.165	9 8 7 4 3 3	
2	A (See Note 1)	16 (See Note 2)	Resistance per 25 feet of duplex wire = 7.00 +0.00. -0.80 ohms at +25° C		0.295	9-chromel 5-alumel	1.0/25 feet
3	A (See Note 1)	13 (See Note 2)	Resistance per 50 feet of duplex wire = 7.00 +0.00. -0.80 ohms at +25° C		0.330	18-chromel 9-alumel	3.0/50 feet
4	A (See Note 1)	10 (See Note 2)	Resistance per 100 feet of duplex wire = 7.00 +0.00. -0.80 ohms at +25° C		0.400	35-chromel 18-alumel	10.0/100 feet

Note 1. Type 1, Classes C and E, and Types 2, 3, and 4 are duplex (two conductor) wire.

Note 2. Sizes shown are approximate to facilitate part numbering.

3.3.1.3 Electromotive force. The temperature-electromotive force relationship of the chromel and alumel conductors forced together as a thermocouple shall conform to requirements in Table II within the tolerances listed in Table III. (see 4.3.2)

3.3.1.4 Splices. Splices in individual strands of a stranded conductor shall be of the butt type. Splices in strands which are composed of a group of individual strands shall be of the butt type. Butt type splices shall be brazed with silver solder. Splices shall be so constructed and disposed throughout the conductor that the diameter, configuration,

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conductor resistance, flexibility, and mechanical strength of the completed conductor are not adversely affected.

TABLE II. Corresponding values of temperature and electromotive force, reference junction temperature of 0°C.

Temperature ° C	° F	Electromotive Force – MV	Temperature ° C	° F	Electromotive Force –MV	Temperature ° C	° F	Electromotive Force – MV
-100	-148	-3.19	270	518	10.97	640	1184	26.60
-90	-130	-3.19	280	536	11.38	650	1202	27.03
-80	-112	-2.87	290	554	11.80	660	1220	27.45
-70	-94	-2.55	300	572	12.21	670	1238	27.87
-60	-76	-2.21	310	590	12.62	680	1256	28.29
-50	-58	-1.86	320	608	13.04	690	1274	28.72
-40	-40	-1.50	330	626	13.45	700	1292	29.14
-30	-22	-1.14	340	644	13.87	710	1310	29.56
-20	-4	-0.77	350	662	14.29	720	1328	29.98
-10	+14	-0.39	360	680	14.71	730	1346	30.40
0	32	0.00	370	698	15.13	740	1364	30.82
+10	50	+0.40	380	716	15.55	750	1382	31.23
20	68	0.80	390	734	15.97	760	1400	31.65
30	86	1.20	400	752	16.40	770	1418	32.07
40	104	1.61	410	770	16.82	780	1436	32.48
50	122	2.02	420	788	17.24	790	1454	32.90
60	140	2.43	430	806	17.65	800	1472	33.30
70	158	2.85	440	824	18.08	810	1490	33.71
80	176	3.26	450	842	18.50	820	1508	34.12
90	194	3.68	460	860	18.93	830	1526	34.53
100	212	4.10	470	878	19.36	840	1544	34.94
110	230	4.51	480	896	19.78	850	1562	35.35
120	248	4.92	490	914	20.21	860	1580	35.76
130	266	5.35	500	932	20.65	870	1598	36.16
140	284	5.73	510	950	21.07	880	1616	36.56
150	302	6.13	520	968	21.49	890	1634	36.96
160	320	6.53	530	986	21.92	900	1652	37.36
170	338	6.93	540	1004	22.34	910	1670	37.76
180	356	7.33	550	1022	22.77	920	1688	38.16
190	374	7.73	560	1040	23.20	930	1706	38.56
200	392	8.13	570	1058	23.62	940	1724	38.96
210	410	8.53	580	1076	24.05	950	1742	39.35
220	428	8.93	590	1094	24.48	960	1760	39.75
230	446	9.34	600	1112	24.91	970	1778	40.14
240	464	9.74	610	1130	25.33	980	1796	40.53
250	482	10.15	620	1148	25.75	990	1814	40.92
260	500	10.56	630	1166	26.18	1000	1832	41.31

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TABLE III. Electromotive force tolerance.

Type	Class	Temperature Range	Tolerance
1	A, B, C D, and E	0° C to 350° C 350° C to 1000° C	±2.8° C ±0.75 Percent
2, 3 and 4	A	0° C to 300° C	±4.0° C

3.3.1.5 Size. The area of the conductors for Type 1 shall be as specified in Table I. The area of the conductor shall not exceed 5 percent under or 5 percent over the nominal value specified.

3.3.2 Insulation. The wire insulation shall consist of a concentric layer or layers of suitable materials, capable of meeting the requirements specified herein. The insulation shall be readily removed with the conventional wire stripping machine and shall have a uniform surface and cable diameter.

3.3.2.1 Inner wrap. The inner wrap, if used, shall consist of a suitable material which shall be braided, woven, or wrapped tightly about the stranded conductor and be capable of meeting the requirements specified herein. The material shall not cause corrosion of the conductor when subjected to the temperature requirements of this specification.

3.3.2.2 Primary insulation. Each conductor shall have a primary insulation consisting of a concentric layer of glass fibers or a multiple layer wrap of a suitable synthetic resinous tape, or other material capable of meeting the requirements specified herein. Where a fibrous primary insulation is used, the material shall be impregnated with a silicone resin or other suitable compound and so applied that it will not enter the conductor strands and affect good electrical contact. The impregnation compound shall bond the insulation sufficiently to prevent fraying under normal conditions of installation.

3.3.2.3 Covering (individual conductors).

3.3.2.3.1 General. The covering, if used, shall consist of a braid, fibrous covering, or other approved material placed over the primary insulation. The covering shall be saturated with a non-hygroscopic and flame-retardant compound which will not affect the colors of the braid to such an extent that the colors cannot be easily distinguished. The saturating compound shall bond the covering sufficiently to prevent fraying under normal conditions of installation.

3.3.2.3.2 Color. The insulation of thermocouple wire shall be color coded to indicate the metallic composition and polarity of the wires.

3.3.2.4 Duplexing outer covering.

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3.3.2.4.1 General. Each duplex wire shall have an individual insulated chromel and alumel conductor laid side by side and covered with a tightly woven braid of glass fiber or other suitable material.

3.3.2.4.2 Color. The duplexing outer braid of the wire shall be color coded in accordance with Tables IV, V, and VI below.

TABLE IV. Insulation color code for single*, duplex, and extension thermocouple wires.

Metallic Composition	Color code	
	Positive	Negative
Iron (+) – Constantan (-)	Black	Yellow
Copper (+) – Constantan (-)	Red	Yellow
Chromel (+) – Alumel (-)	White	Green

*For single thermocouple wires, the individual insulated wire shall be color coded as indicated above, based on the metallic composition and polarity specified, i.e., iron (+) = black, alumel (-) = green.

TABLE V. Jacket color code for duplex thermocouple wires.

Metallic Composition	Color code	
	Overall	Tracers
<u>Iron-constantan</u> <u>Type I – Solid or stranded conductors</u>		
Class C – Solid conductors, high accuracy EMF	Light Blue	1-Red 1-Blue
Class E – Stranded conductors, high accuracy EMF	Light Blue	1-Red 1-Blue
Class H – Stranded conductors, standard accuracy EMF	Light Blue	2-Red 1-White
Class J – Stranded conductors, standard accuracy EMF	Light Blue	2-Red 1-White

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TABLE V. Jacket color code for duplex thermocouple wires - Continued.

Metallic Composition	Color code	
	Overall	Tracers
<u>Copper-constantan</u>		
<u>Type I – Solid or stranded conductors</u>		
Class C – Solid conductors	Black	-
Class E – Stranded conductors	Black	-
<u>Chromel – Alumel</u>		
<u>Type I – Solid or stranded conductors</u>		
Class C – Solid conductors	White	-
Class E – Stranded conductors	White	-

TABLE VI. Jacket color code for thermocouple extension wires.

Metallic Composition	Color code	
	Overall	Tracers
<u>Iron-constantan</u>		
<u>Type II – Stranded conductors (8 ohms per 100 foot length)</u>		
Class A – Each strand of iron wire tinned. (120° C.)	Light Blue	-
Class B – Each strand of iron wire tinned. (230° C.)	Light Blue	1-Red
Class C – Iron wire not tinned.	Light Blue	1-White

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TABLE VI. Jacket color code for thermocouple extension wires – Continued.

Metallic Composition	Color code	
	Overall	Tracers
<u>Type III – Stranded conductors (8 ohms per 200 foot length)</u>		
Class A – Each strand of iron wire tinned. (120° C.)	Light Blue	2-Black
Class B – Each strand of iron wire tinned. (230° C.)	Light Blue	2-Red
Class C – Iron wire not tinned.	Light Blue	2-White
<u>Copper-constantan</u>		
<u>Type I – Stranded conductors</u>		
Class F – (120° C.)	Black	1-Yellow
Class G - (230 C.)	Black	2-Yellow
<u>Type II – Stranded conductors (7 ohms per 200 foot length)</u>		
Class A - (120° C.)	Black	1-White
Class B - (230° C.)	Black	2-White
<u>Type III – Stranded conductors (20 gage copper, 18 gage constantan)</u>		
Class A - (120° C.)	Black	1-Green
Class B - (230° C.)	Black	2-Green

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TABLE VI. Jacket color code for thermocouple extension wires – Continued.

Metallic Composition	Color code	
	Overall	Tracers
<u>Type IV – Stranded conductors (20 gage copper, 16 gage constantan)</u>		
Class A – (120° C.)	Black	1-Red
Class B – (230° C.)	Black	2-Red
<u>Type IV – Stranded conductors (18 gage copper, 14 gage constantan)</u>		
Class A – (120° C.)	Black	1-Yellow 1-Green
Class B – (230 C.)	Black	1-Yellow 2-Green
<u>Chromel-alumel</u>		
<u>Type II – Stranded conductors (7 ohms per 25 foot length)</u>		
Class A - (315° C.)	White	1-Green
<u>Type III – Stranded conductors (7 ohms per 50 foot length)</u>		
Class A - (315° C.)	White	2-Green
<u>Type IV – Stranded conductors (7 ohms per 100 foot length)</u>		
Class A - (315° C.)	White	3-Green

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3.3.3 Finished wire.3.3.3.1 Length.

3.3.3.1.1 Type 1. Unless otherwise specified by the procuring activity, the quantity of wire specified in the contract or purchase order shall be furnished in one continuous length. Classes A, B, and D chromel and alume wire comprising the lot or order shall be furnished by the same manufacturer and shall be furnished on separate coils or reels. (see 6.2.1)

3.3.3.1.2 Type 2. Unless otherwise specified, the wire shall be supplied in coils or reels in continuous lengths of 250 feet or multiples thereof.

3.3.3.1.3 Type 3. Unless otherwise specified, the wire shall be supplied in coils or reels in continuous lengths of 500 feet or multiples thereof.

3.3.3.1.4 Type 4. Unless otherwise specified, the wire shall be supplied in coils or reels in continuous lengths of 500 to 1,000 feet.

3.3.3.1.5 Tolerance. The length of the wire supplied in each coil or reel shall not vary more than -5 to +10 percent of the value specified.

3.3.3.2 Color. All colors of finished wire shall be distinctive, reasonably permanent, and resistant to the solvents listed in 4.6.11 and Table VII. If the colors can be distinguished, they shall not be considered as faded.

3.3.3.3 Resistance. The resistance of finished Types 2, 3, and 4 wire, when calculated to two decimal places, shall be as specified in Table I (see 4.3.3)

3.3.3.4 Diameter. The diameter of the finished wire shall not exceed the dimensions given in Table I.

3.3.3.5 Weight. The weight of the finished wire shall not exceed the values given in Table I.

3.4 Performance.

3.4.1 Dielectric strength. The wire shall be capable of withstanding a potential of 350v rms at a commercial frequency for 5 minutes without breakdown or flashover when tested as specified. (see 4.3.4)

3.4.2 Insulation resistance. The insulation resistance of the finished wire shall be not less than 100 mega ohms per 1,000 feet at a temperature of 15.5° C when tested as specified. (see 4.3.5)

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3.4.3 Temperature aging. The wire shall be aged for a period of 96 hours as specified (see 4.3.6). After which the wire shall be subjected to the bend test (see 4.3.7) and then meet the requirements of 3.4.1 and 3.4.2.

3.4.4 Cold bend. The wire shall withstand a temperature of $-55^{\circ}\text{C} \pm 2^{\circ}\text{C}$ without cracking of the insulation or of the outer protective coating when tested as specified (see 4.3.8). After which the wire shall meet the requirements of 3.4.1.

3.4.5 Heat resistance. The wire shall withstand a temperature of $315 \pm 5^{\circ}\text{C}$ without cracking of the insulation or outer protective coating when tested as specified (see 4.3.9). After which the wire shall meet the requirements of 3.4.1.

3.4.6 Flammability. When tested as specified (see 4.3.10), the rate of burning shall not exceed 1 inch per minute and during the test no burning or charred particles shall fall from the wire.

3.4.7 Solvent resistance. When tested as specified (see 4.3.11), there shall be no deterioration of the insulation or of the outer protective coating and the wire shall meet the requirements of 3.4.1 and 3.4.2 after the solvent immersion.

3.4.8 Fungus resistance. The wire shall show no evidence of fungus growth when tested as specified (see 4.3.12), and shall meet the requirements of 3.4.1 after the fungus exposure.

3.4.9 Abrasion resistance. The wire shall have abrasion resistance sufficient to withstand the test specified (see 4.3.13) without exposing the conductor.

3.5 Identification of product. Each coil or reel shall be marked with a durable tag, securely attached to the wire, containing information in accordance with MIL-STD-130. In addition, the following information shall be included:

Wire, Electrical, Chromel, Thermocouple

or

Wire, Electrical, Alumel, Thermocouple

or

Wire, Electrical, Chromel and Alumel, Thermocouple
(as applicable)

Type

Class

Length ___ feet

Manufacturer's Lot No.

Federal Stock No.

Military Part No.

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3.6 Workmanship. The wire shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and to freedom of parts from burrs and sharp edges.

4. VERIFICATION

4.1 Preproduction inspection. Unless otherwise specified in the contract or purchase order, preproduction inspection shall be performed by the supplier, after award of contract and prior to production, at a location acceptable to the Government. Preproduction inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. Preproduction approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders. (see 6.4)

4.1.1 Sample size. Preproduction inspection sample(s) shall consist of 50 feet of each type and class of wire on contract or purchase order.

4.1.2 Inspection routine. The samples shall be subjected to the inspections specified in Table VII as described under 4.3 methods of examination and test.

Table VII. Preproduction inspection routine.

Type	1	2	3	4
Class	ABCDE	A	A	A
General Inspection	XXXXX	X	X	X
Electromotive Force	XXXXX	X	X	X
Resistance	XXXX	X	X	X
Dielectric Strength	XXXX	X	X	X
Insulation Resistance	XXXX	X	X	X

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Table VII. Preproduction inspection routine – Continued.

Type	1	2	3	4
Class	ABCDE	A	A	A
Temperature Aging	XXXX	X	X	X
Bend	XXXX	X	X	X
Cold Bend	XXXX	X	X	X
Heat Resistance	XXXX	X	X	X
Flammability	XXXX	X	X	X
Solvent Resistance	XXXX	X	X	X
Fungus Resistance	XXXX	X	X	X
Abrasion Resistance	XXXX	X	X	X

X= Applicable inspection.

4.2. Quality conformance inspection. Quality conformance inspections shall consist of:

- a. Individual inspections (see 4.2.1).
- b. Sampling plans and tests (see 4.2.2).

4.2.1 Individual inspection. The wire shall be subjected to the following inspections as described in 4.3 methods of examination and test.

- a. Examination of product.
- b. Electromotive force.
- c. Resistance.
- d. Dielectric strength.
- e. Insulation resistance.

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4.2.2 Sampling plans and tests.

4.2.2.1 Sampling plan A. Unless otherwise specified by the procuring activity, for each 50,000 feet of wire for controlled inspection stocks on contract(s) or order(s), a total of 12 samples shall be selected at random from the shipping coils and reels. Not more than three samples shall be selected from any one coil or reel if four or more coils or reels are supplied. The number of samples for each test shall be as specified in the test methods. The samples shall be subjected to the test listed below. Any number of contracts or orders may be supplied on the basis of the results of one series of sampling tests provided that all of the wire is of the same type and class, is part of a batch previously sampled, and is submitted for shipment within 24 months after the sampling tests are conducted. If identical insulation is used on a number of classes of wire that are manufactured and submitted for test at substantially the same time, the inspector shall so select the samples as to get at least three samples from each class of wire. Only one series of sampling tests is required for each 50,000 feet total of the various classes of wire.

- a. Individual inspection.
- b. Temperature aging.
- c. Heat resistance.
- d. Flammability.
- e. Solvent resistance.

4.2.2.2 Rejection and retest. When one sample selected from a production run fails to meet the specification, no wire from which the sample was taken shall be accepted until the extent and cause of failure are determined. This applies to all wire of the same batch or lot for individual and sampling plan A tests.

4.2.2.3 Individual tests may continue. For operational reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of items on hand or later produced shall not be made until it is determined that the wire meets all the requirements of individual and sampling plan A tests. Additional sampling tests shall be conducted. If a failure occurs during these tests, the sampling test shall immediately revert to individual tests until the batch is tested.

4.2.2.4 Defects in items already accepted. The investigation of a test failure could indicate that defects may exist in items already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and methods of correcting them.

4.3. Methods of examination and test.

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4.3.1 Examination of product. The wire shall be subjected to a thorough general inspection to ascertain that the materials, workmanship, and design are in strict conformity with the requirements of this specification. The general inspection shall cover requirements such as dimensions, color coding, weight, conformity of materials to specification requirements, and ease of insulation stripping.

4.3.2 Electromotive force. (see 3.3.1.3)

4.3.2.1 Type 1, Classes A, B, C, D, and E. A thermocouple shall be formed from a specimen taken from each coil or reel to be supplied in the contract or purchase order. The electromotive force characteristics of the wire shall be determined at temperatures of approximately 0°, 200°, 400°, 600°, 800°, and 1,000° C. The electromotive force characteristics shall meet the tolerances specified in Table III.

4.3.2.2 Type 2, 3, and 4, Class A wire. A thermocouple shall be formed from a specimen of the wire, and the electromotive force characteristics of the wire shall be determined at temperatures of approximately 0°, 100°, and 200° C. The measured electromotive force shall meet the tolerances listed in Table III. One specimen shall be taken from each coil or reel of the wire.

4.3.3 Resistance. The total resistance (chromel and alumel conductor) of each finished coil or reel of wire shall be determined at, or the determined resistance corrected to, 25°C and shall be expressed as resistance per 25 feet for Type 2 wire, 50 feet for Type 3 wire, and 100 feet for Type 4 wire. The wire shall be certified, stating the resistance to two decimal places calculated for a length of 25, 50, or 100 feet as applicable for 25° C, date of test, and name of person performing the test. In making this test, care shall be exercised so that any thermal emf developed by joining the chromel and alumel wire does not affect the results. The resistance of the wire shall conform to Table I. The following expressions may be used for converting resistances measured at temperatures other than 25° C to resistance at 25° C:

$$\begin{array}{l} \text{Chromel conductor} \\ R_{25} = 3100 + c \end{array}$$

$$\begin{array}{l} \text{Alumel conductor} \\ R_{25} = 432.96 + c \end{array}$$

Where R₂₅ is Resistance at 25° C

R_t is Resistance at temperature (t) in ohms.

Temperature at which resistance was measured in degrees Celsius.

4.3.4 Dielectric strength. One inch of the insulation shall be removed from each end of three 36-inch specimens of the wire. The samples shall be immersed in a saturated

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solution of salt water at a temperature of 25° C to a point 5 inches from each end of the insulations for a period of 20 hours. Following this period, a potential of 350v rms at a commercial frequency shall be applied to the specimen. The potential shall be applied to the specimen through grounding the outer surface of the insulation by immersion in the salt solution at not over 30° C and the voltage applied between each conductor and ground. The wire shall be capable of withstanding this potential for 5 minutes without breakdown. (see 3.4.1)

4.3.5 Insulation resistance. The samples of wire subjected to the dielectric strength test shall then be subjected to the insulation resistance test. Insulation resistance measurement shall be made with a mega ohm bridge or with a galvanometer and a suitable source of direct current. The measurement shall be made with the specimen immersed in a saturated solution of salt water, at a temperature of 25° C, to a point 6 inches from each end of the insulation. The insulation resistance shall be determined between each conductor and ground after 1 minute electrification with a potential of not less than 200 or not greater than 500 V dc. The insulation resistance of the finished wire 1,000 feet in length shall be determined as follows: During this test, the temperature of the wire shall be as nearly uniform as practicable. The measured insulation resistance shall be corrected to a reference temperature of 15.5° C by multiplying the measured value of insulation resistance by a coefficient corresponding to the temperature of the measurement. These temperature coefficients are shown in Table VIII. For temperature values between those tabulated, the coefficient for the next higher temperature shall be used when above 15.5° C, and that of the next lower temperature shall be used when below 15.5° C. For approved insulating materials possessing temperature coefficients not within the limits set by this reference characteristic, the values applicable thereto may be used when specifically approved by the procuring activity. (see 3.4.2)

TABLE VIII. Temperature coefficients.

Temperature Degrees F	Temperature Degrees C	Temperature Coefficients of Insulation
32	0.0	0.032
35	1.7	0.047
38	3.3	0.071
41	5.0	0.098
44	6.7	0.140
47	8.3	0.25
50	10.0	0.29
53	11.7	0.45
56	13.3	0.78
59	15.0	0.91

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TABLE VIII. Temperature coefficients - Continued.

Temperature		Temperature Coefficients of Insulation
Degrees F	Degrees C	
60	15.5	1.00
62	16.7	1.26
65	18.3	1.80
68	20.0	2.50
71	21.7	3.50
74	23.3	5.00
77	25.0	6.60
80	26.7	8.30
83	28.3	11.0
86	30.0	17.5
89	31.7	24.5
92	33.3	34.0
95	35.0	48.0

4.3.6 Temperature aging. One inch of the insulation shall be removed from each end of a 36-inch specimen of the finished wire. The specimen shall be suspended in a suitable test chamber without touching the walls of the chamber. The chamber shall be maintained at a temperature of $100^{\circ} \pm 2^{\circ}$ C. The heated air, at atmospheric pressure, in the chamber shall be circulated so as to maintain a uniform temperature. The specimen shall be subjected to this temperature for a period of 96 hours and then subjected to the bend, dielectric, and insulation resistance tests, respectively. (see 3.4.3)

4.3.7 Bend. One end of the specimen shall be secured to a mandrel and the other end to the load weight specified in Table IX. The mandrel shall be rotated until the full length of the specimen is wrapped around the mandrel and is under the specified tension with adjoining coils in contact. The mandrel shall then be rotated in the reverse direction until the full length of the specimen is wrapped around the mandrel as before, except that the reverse surface of the wire is in contact with the mandrel. This procedure shall be repeated until two bends in each direction have been formed in the same section of the wire. When this test is conducted on duplex wire, the bend shall be made on the minor diameter of the wire. (see 3.4.3)

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TABLE IX. Bend diameters and loads.

Gage	Mandrel Diameter (Inches) Bend Test and Code Bend Test	Maximum Test Load (Lb) Bend Test
14	3	1.0
16	3	1.0
18	2	1.0
20	2	.75
24	1	.75
26	1	.75
Type 2 Class A	3	1.0
Type 3 Class A	3	2.0
Type 4 Class A	3	3.0

4.3.8 Cold bend. Three straight specimens of the finished wire shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The wire shall be subjected to a temperature of -55° C for a period of 4 hours. At the end of this period and while still at -55° C, the specimens shall be wrapped about a mandrel mounted within the cold chamber as specified in Table VI, at the rate of one turn in 4 seconds, for a sufficient number of turns so that the center portion of the wire is subjected to at least two complete turns. The specimens shall be wrapped and rewrapped in the opposite direction in a similar manner. Either a revolving or stationary mandrel may be used. The specimens shall then be removed from the mandrel and, without straightening, shall be subjected to and meet the requirements of the dielectric test as specified herein. When the test is conducted on duplex wire, the bend shall be made on the minor diameter of the wire. (see 3.4.4)

4.3.9 Heat resistance. A specimen of finished wire shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The specimen shall be placed in an oven maintained at $315^{\circ} \pm 5^{\circ}$ C for 24 hours. At the end of this time, the specimen shall be removed and allowed to return to room temperature. The specimen shall then be wound tightly around a mandrel five times the major diameter of the wire for five close turns and removed without straightening. The coil section shall then be subjected to and meet the requirements of the dielectric test as specified herein. There shall be no cracking or other failure of the insulation as a result of this test. When this test is conducted on duplex wire, the bend shall be made on the minor diameter of the wire. (see 3.4.5)

4.3.10 Flammability. A 20-inch length of the finished wire shall be marked with fine threads at distances 5 and 11 inches from one end of the specimen to designate a 6-inch test length. The specimen shall be held tautly in a horizontal position within a chamber approximately 2 x 1 x 1 foot, open at the top and one long side, and which allows sufficient flow of air for complete combustion, which is free from drafts. A flame from a Bunsen burner shall be applied, for 30 seconds and then removed, to the end of the specimen from which distances were measured. The Bunsen burner shall have a 1/4-inch

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inlet, a nominal bore of 3/8 inch, and a length of approximately 4 inches from top to primary inlets. The burner shall be adjusted to produce a 2-inch flame with an inner cone 1/3 of the flame height. The burner height shall be so adjusted that the hottest portion of the flame is applied to the wire. The time of burning shall then be recorded as the time required for the flame to progress along the marked 6-inch length. (see 3.4.6)

4.3.11 Solvent resistance. Five specimens of finished wire, each 2 feet long, shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The center 1-foot section of the specimen shall be immersed in the solvents listed in Table X for 24 hours at 25° C, removed, and wiped clean with a dry cloth. Any one specimen shall not be immersed in more than one solvent. The center 1-foot section shall be subjected to and meet the requirements of the dielectric and insulation resistance tests specified herein. All specimens shall be immersed in the salt water specified for dielectric test and tested immediately with no soaking required. (see 3.4.7)

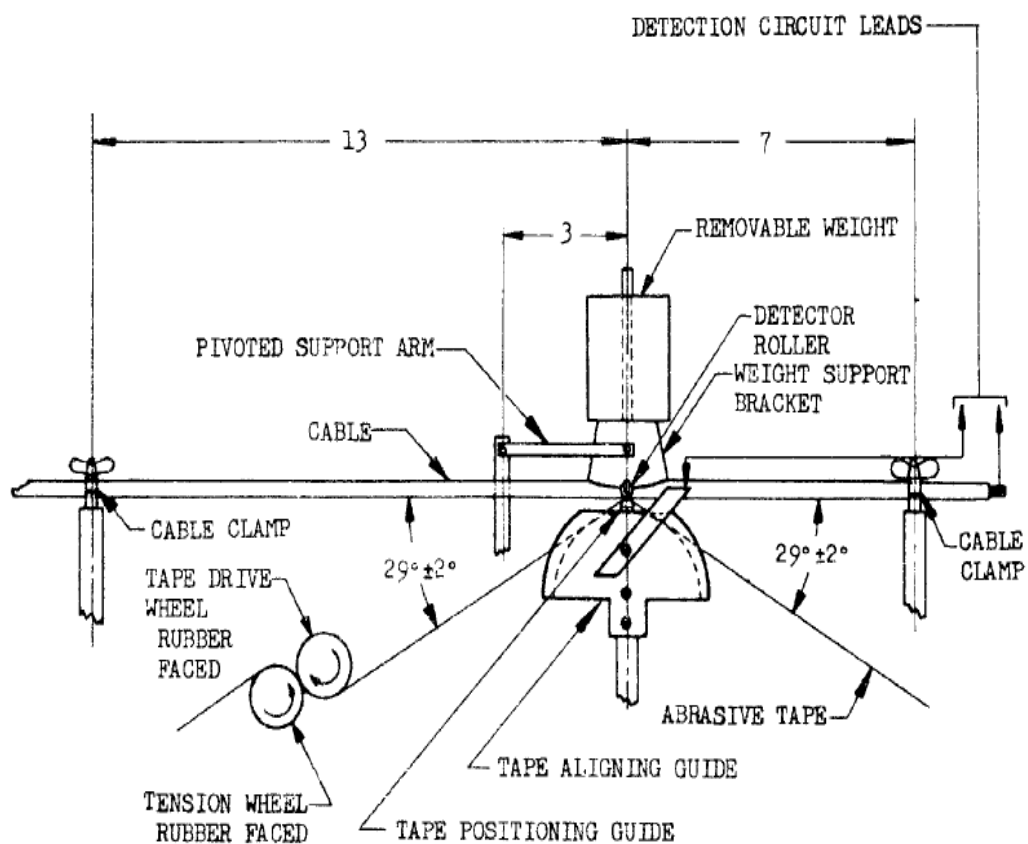
TABLE X. Test solvents.

Solvent	Reference
Saturated solution of salt water	-----
Ethylene glycol	A-A-52624
Isopropyl alcohol	TT-I-735
Standard test fluid Type II	ASTM D471
Engine oil Grade 1065	SAE-J1966

4.3.12 Fungus. Three specimens of finished wire, each 2 feet long, shall be prepared by removing 1 inch of insulation from each end to the bare conductor. The specimens shall be subjected to the fungus test, IAW Method 508 of MIL-STD-810. At the completion of the exposure period, the specimen shall be examined for evidence of fungus growth. There shall be no evidence of fungus growth on the specimen. The center 1-foot section, within 15 minutes after removal from the test chamber, shall be subjected to and meet the requirements of the dielectric test as specified herein. (see 3.4.8)

4.3.13 Abrasion resistance. Three specimens of finished wire, each 2 feet long, shall be subjected to the abrasion test. The specimens shall be tested with an abrasion tester equivalent to Figures 1, 2, and 3, sufficient to test finished wires as listed in Table XII. The length of the abrasive tape, the weight applied, and the support bracket used shall be as specified in Table XII. Only the finished insulation of the individual conductors, not duplexing outer covering, of duplex wire shall be subjected to the abrasion resistance test. (see 3.4.9)

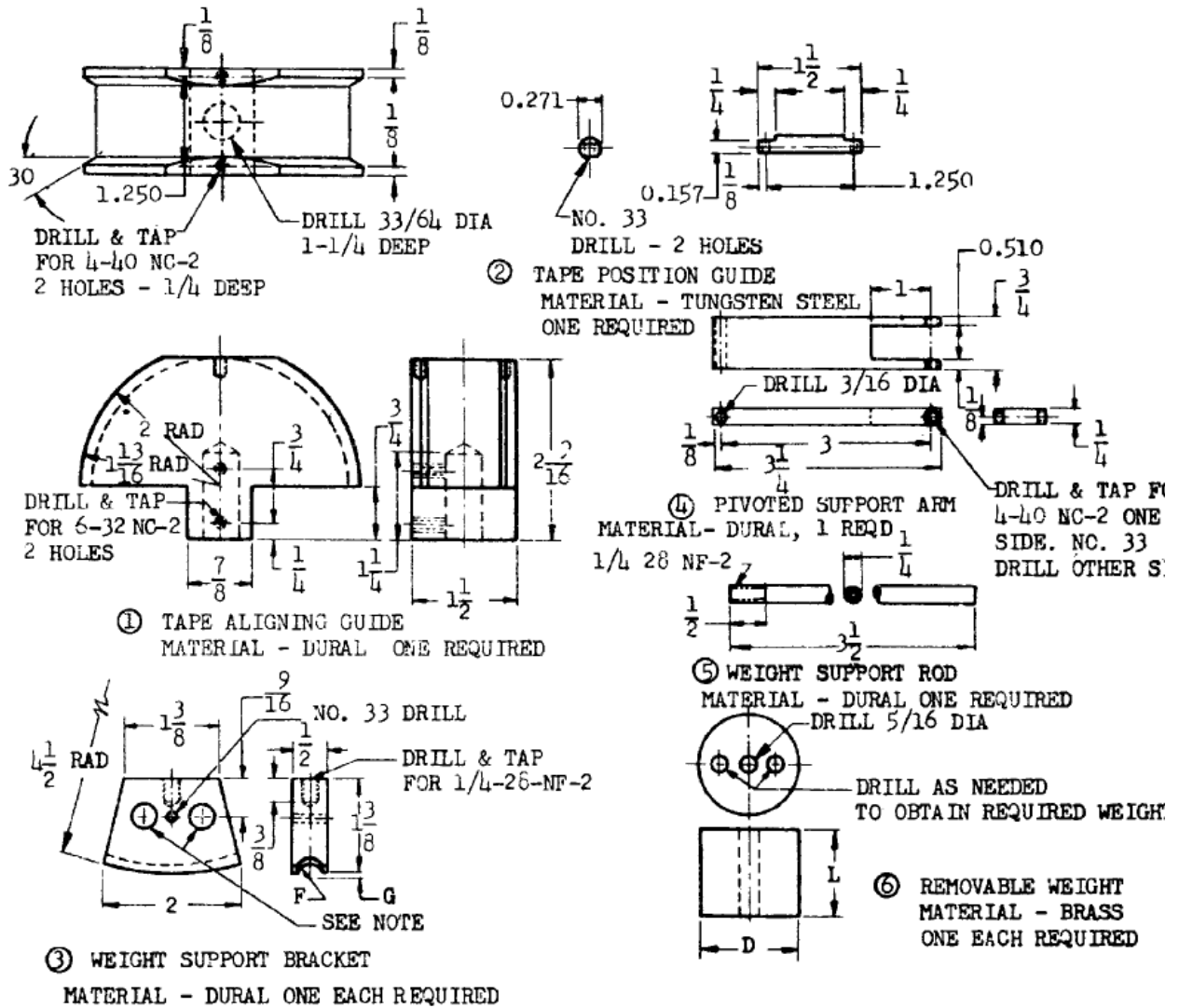
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Dimensions are in inches unless otherwise specified.

FIGURE 1. Assembly sketch of abrasion tester.

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BRACKET	F	G
A	1/32	1/64
B	1/16	1/32
C	3/16	1/16

WEIGHT	D	L
1.0 LBS	1-3/4	1-1/2
3.0 LBS	2-1/4	2-9/16
4.25 LBS	2-1/2	2-13/16

NOTE: WEIGHT OF BRACKET AND WEIGHT SUPPORT ROD TO BE 0.12 LBS. DRILL HOLES TO SUIT TO OBTAIN REQUIRED WEIGHT.

Dimensions are in inches unless otherwise specified.

FIGURE 2. Detail drawing of parts for abrasion tester.

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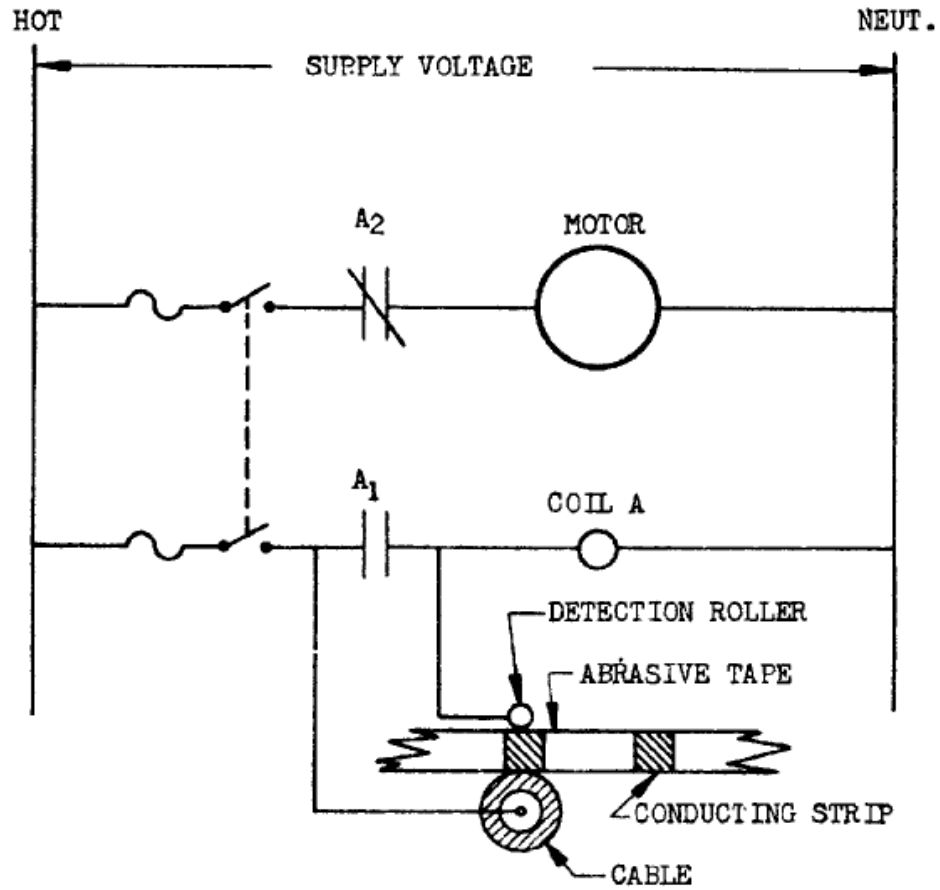


FIGURE 3. Schematic wiring diagram of abrasion tester.

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TABLE XII. Abrasion resistance.

American Wire Gage	Length of Tape – Inches	Weight Lb	Support Bracket
26	16	1.0	A
24	16	1.0	A
22	16	1.0	A
20	16	1.0	A
18	16	1.0	A
16	22	1.0	A
14	10	3.0	B
13	10	3.0	B
12	10	3.0	B
10	10	3.0	B
8	19	3.0	B
6	21	3.0	C

4.4 Preparation for delivery.

4.4.1 Preservation, packaging and packing. Wire shall be prepared for delivery in accordance with preservation-packaging and packing conforming to Levels A, B, or C requirements of MIL-DTL-12000 unless otherwise specified in the procurement document.

4.4.2 Marking. Reels, coils and interior packages shall be marked in accordance with MIL-STD-129 and shall contain, as applicable, the information listed below. Paper labels, when used, shall be protected by a transparent coating to prevent deterioration of marking.

- a. Federal Stock Number (FSN).
- b. Wire, Electrical, Chromel, Thermocouple
or
Wire, Electrical, Alumel, Thermocouple
or
Wire, Electrical, Chromel and Alumel, Thermocouple
(as applicable)
MIL-DTL-5846, Type __*__, Class __*__
Conductor qty __*__ and size __*__ (Type 1 only).
- c. * Supply information as applicable.
- d. Federal Supply Code of Manufacturers (FSCM) and Manufacturer part number.
- e. Contract or order number.

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- f. Level of preservation-packaging and date (month and year).
- g. Date of manufacture.
- h. Manufacturer lot number (Type 1, Classes A, B, and D only).
- i. Military part number.
- j. Manufacturer's name or trade mark (unless coded in (4) for FSCM above).
- k. Name of contractor (if not the manufacturer).
- l. Additionally, Type 1 Classes A, B, and D shall contain marking as follows:

“CAUTION: Chromel and Alumel wire contained herein are calibrated for use together in fabricating thermocouples. If different lot numbers are used, recalibration of wire will be required.”

5. PACKAGING.

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

6.1.1 Type 1 Classes A, B, C, D, and E. Type 1 Classes A, B, C, D, and E wire are intended for fabricating thermocouples.

6.1.2 Types 2, 3, and 4, Class A. Types 2, 3, and 4, Class A wire are intended for fabricating thermocouple extension leads for aircraft use. The wire is intended for applications where temperatures of 315° C are to be encountered.

6.2 Ordering data.

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6.2.1 Procurement requirements. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Military part number. (see 1.2.1)
- c. Unless otherwise specified, a preproduction test sample is required. (see 3.1)
- d. Unless otherwise specified, sampling plan A tests will be conducted. (see 4.2.2.1)
- e. Levels of preservation, packaging, and packing. (see 4.4.2.f)
- f. Type 1, Classes A, B, and D chromel and alumel wire comprising the lot or order should be procured from the same manufacturer to insure that calibration requirements are met. (see 3.3.3.1.1)

6.3 Preproduction test report. A preproduction test report in accordance with MIL-HDBK-831 should be submitted to the procuring activity along with the preproduction inspection sample for approval after completion of testing. MIL-HDBK-831 may be used as a guideline for preparing the preproduction test report. The contractor will not be permitted to begin production until the test report and samples are approved by the procuring activity.

6.4 Preproduction. The preproduction sample should be examined and tested for approval at the contractor's plant or at an independent commercial testing laboratory acceptable to the procuring activity. Preproduction tests will be witnessed by a Government representative of the procuring activity. The contracting officer will approve the preproduction sample.

6.5 Use of the terms chromel and alumel. The use of chromel and alumel in this specification is based on the definition of these terms as used by industry for several years. It is recognized, however, that these terms are trade names of the Hoskins Manufacturing Company. Accordingly, the use of these terms herein is not intended to prohibit the use of materials manufactured or produced by other sources when the materials otherwise meet the requirements of this specification.

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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Custodians:

Army – MI
Navy – AS
Air Force – 11

Preparing Activity

Army – MI

(Project No. 6145-2008-105)

Review Activities:

Army – GL, AV
Navy – OS
DLA – CC

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above by using the ASSIST Online database at <http://assist.daps.dla.mil>.